SANTA CRUZ HIGHWAY 1 HOT LANES FEASIBILITY STUDY

Summary Report

prepared for

Santa Cruz County Regional Transportation Commission
1523 Pacific Avenue
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September 20, 2002

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Background

The *Santa Cruz HOT Lanes Feasibility Study (Feasibility Study)* was a cooperative study financed by the Santa Cruz Regional Transportation Commission (SCCRTC) and the Federal Highway Administration's (FHWA) Value Pricing Demonstration Program. The study included participation of Caltrans and various Santa Cruz County agencies through the Interagency Project Review Team (IPRT).

The principal purpose of the study was to investigate the potential application of the High Occupancy Toll (HOT) lane concept on the five-mile section of Highway 1 between State Park Drive and Morrissey Boulevard that is currently proposed for widening. The study corridor extends approximately 6.3 miles in Santa Cruz County between the State Park Drive/Seacliff interchange in Aptos, and the interchange of Highway 1 and Route 17 in the City of Santa Cruz. Highway 1 in this section is a four-lane divided freeway with a two- to eleven- meter median width. Within the study limits there are seven interchanges, including the freeway-to-freeway interchange with Route 17 at the northwest end of the study corridor. The *Feasibility Study* was conducted concurrently with the *Project Study Report (PSR)*[1] for the same stretch of highway prepared by Caltrans District 5, and was undertaken to help the public and decision-makers address the issues related to traffic congestion on this section of Highway. The concurrent effort on the *Feasibility Study* and the *PSR* allowed for efficiencies in the data collection and travel demand modeling efforts, and consistency in data used for the analysis.

"HOT" lanes are designated special use lanes on an otherwise free highway facility. On HOT lanes, single- or low-occupancy vehicles are charged a toll, while High Occupancy Vehicles (HOV) are allowed to use the lanes free or at a discounted toll rate. Vehicles not meeting the HOV occupancy requirements could buy the right to use the HOT lanes. The lanes are managed such that they remain uncongested at all times, including during peak hours.

The *Feasibility Study* was separated into three distinct phases, with a decision point at the end of Phase 1. Phase 1 included determining whether the implementation of a HOT lane on Highway 1 in the study corridor would be physically feasible and in what configuration, whether future traffic conditions would make it financially feasible with respect to toll revenues, and what would be the HOT lane's effectiveness in managing congestion in the corridor. At the end of Phase 1, if a HOT lane is determined to be feasible and desirable for the corridor, the *Feasibility Study* would then proceed to Phase 2, which would include a detailed financial analysis, an equity/social justice analysis and a public acceptance analysis. Phase 3 would involve documentation of Phase 1 or Phases 1 and 2 if the *Feasibility Study* proceeded to Phase 2.

[1] The *Project Study Report for Widening on Route 1 in Santa Cruz County in and near Capitola and Santa Cruz between State Park Drive and Morrissey Boulevard* considered a number of options to widen Highway 1, including a No Build (if nothing were to be done), the addition of auxiliary lanes, High Occupancy Vehicle lanes, High Occupancy Toll lanes, mixed-flow lanes and operational improvements such as ramp meters.

The public participation process during Phase 1 included the following actions: monthly IPRT meetings that were open to the public and attended regularly by a number of interested individuals, notices of IPRT meeting dates/times and topics on the SCCRTC website; three Policy Workshops[2] with SCCRTC commissioners and the public to review *Feasibility Study* progress, and presentation of key milestones in the study progress at televised SCCRTC meetings. Monthly status reports were included in the informational packets provided to the SCCRTC commissioners. During the IPRT, Policy Workshop and monthly SCCRTC meetings, technical memoranda and reports presenting data, analysis process and key decisions were made available to the public.

Data Collection

An overview of the existing transportation characteristics and conditions in the study corridor was developed based on field surveys conducted in the spring and summer, and available data from SCCRTC and Caltrans. The data, and its analysis, provided the basis for analysis of the HOT lanes feasibility and served as input into the Caltrans *PSR* for the Highway 1 widening. As part of the data collection effort, a telephone survey of 400 Santa Cruz County residents that use Highway 1 was also conducted.

Evaluation Criteria

The evaluation of the HOT lane feasibility in Phase 1 consisted of two tiers of analysis – a preliminary screening effort of the toll lane concepts, and a detailed evaluation of selected alternatives. Six categories of evaluation criteria were used to conduct the preliminary screening and the detailed evaluation, and measures of effectiveness were developed for each criteria. The categories of evaluation criteria included:

- Engineering Design (for screening and detailed evaluation)
- Benefit/Ability to Solve Problem (for screening and detailed evaluation)
- Cost Factors (for detailed evaluation)
- Environmental (for detailed evaluation)
- Socio-economic (for detailed evaluation)
- Deliverability

Alternatives Selected for Detailed Evaluation

An initial list of 56 alternative HOT lane concepts was developed based on different combinations of physical design (e.g., number of lanes, barrier separated, buffer separated) and operational characteristics (e.g., permit, Electronic Toll Collection, reversible operation). The preliminary screening assessment narrowed down the number of options from 56 to five alternatives for detailed evaluation. The following alternatives were approved by the SCCRTC for detailed evaluation:

- Alternative 1A – one lane in each direction with barrier separation, no intermediate access

[2] The SCCRTC's Transportation Policy Workshop is a meeting of the full Commission once a month in the SCCRTC's conference room to discuss in more detail relevant topics in an informal setting.

- Alternative 2A – one lane in each direction with buffer separation, no intermediate access
- Alternative 3B – one lane in each direction with striped separation, 1 intermediate access point. Highway 1 between 41st and Soquel Avenues was determined to be the only segment in the project limits that contains sufficient length for the weaving section necessary for vehicles to enter and exit the HOT lane at an intermediate access location.
- Alternative 3C – one lane in each direction with striped separation, continuous access
- Alternative 4A – one reversible lane with barrier separation, no intermediate access

Travel Forecast Results

Future year 2020 travel demand forecasts were developed by Caltrans for use in both the *Highway 1 HOT Lanes Feasibility Study* and for the *Highway 1 Widening PSR* that was concurrently being prepared by Caltrans. Travel demand forecasts were prepared using the Association of Monterey Bay Area Governments (AMBAG) travel demand model output for 2000 and 2020 conditions. The year 2000 model output was validated by Caltrans using traffic data collected on Highway 1 in the spring and summer of 2001. The travel demand forecasts were used to determine the likely vehicle demand in the Highway 1 study corridor, and the potential for use of the HOT lane. During the AM and PM peak hours, traffic volumes on Highway 1 are projected to increase by between 34 and 42 percent in the northbound direction, and between 47 and 59 percent in the southbound direction. It should be noted that the travel projections are based on employment and household forecasts from 1997 (1997 Regional Population and Employment Forecasts for Monterey, San Benito, and Santa Cruz Counties), and may change with updates to the regional demographic data.

Project Costs

In developing the project costs, the HOT lane analysis assumed that Highway 1 would be widened by one additional lane in each direction. The *incremental* costs associated with construction and operation/maintenance of the HOT lane (i.e., additional costs over and above the capital costs for widening Highway 1 by one additional lane in each direction, as well as the annual maintenance costs) were developed for each of the five alternatives. The incremental costs would range from $2,500,000 to $21,000,000 for capital costs, and $600,000 to $1,300,000 for annual operations and maintenance costs.

Revenue Estimates

Annual revenue estimates were developed for the Highway 1 HOT lane alternatives using projections of future year 2020 vehicle demand, and a micromodel of the corridor. Annual revenue estimated for year 2020 ranges from about $2,000,000 for Alternative 4A (reversible lane) to about $3,000,000 for Alternatives 1A (barrier separated) and 1B (buffer separated). These revenues reflect the toll rate that would result in the highest revenue, while effectively managing the travel demand and congestion in the HOT lane.

A comparison of the projected revenues to the incremental cost estimates was conducted to assess the financial feasibility of the alternative. The comparison of revenues to costs indicated that HOT lane revenues would cover the incremental operating and maintenance costs, as well as

the incremental capital costs associated with implementation, however, would not substantially cover significant transit improvements and/or capital costs of the planned Highway 1 widening.

Detailed Evaluation

The detailed evaluation of the five alternatives consisted of a quantitative and qualitative assessment of how each alternative would perform with respect to the six evaluation criteria and the 18 measures of effectiveness. A detailed evaluation matrix was developed by the consultant team and the IPRT to assist in the assessment of the alternatives. To the extent possible, the ratings of the measures of effectiveness were based on quantitative assessments of the HOT lane with respect to operations, costs, revenues and travel time savings. The detailed evaluation reduce the number of alternatives under consideration, from five to two. Alternative 3B (one intermediate access) was identified as the best of the five alternatives, although there still were issues related to safety, enforcement and operations in the Highway 1 study corridor.

Study Findings

While HOT lanes may have benefits elsewhere, the results of the *Feasibility Study's* Phase 1 effort indicated that HOT lanes in the Highway 1 study corridor would be subject to a number of design and operation constraints. This finding is primarily due to the situation studied here; a 6.3 mile study corridor, with a proposed five-mile HOT lane, limited right-of-way, multiple interchanges on the adjacent main lanes, and anticipated high levels of HOV traffic. On June 13, 2002, the Regional Transportation Commission voted to not proceed with Phase 2 of the *Feasibility Study* – which would have further analyzed financial feasibility, equity issues and public acceptance – and to not include a HOT lane alternative in subsequent phases of the Highway 1 Widening project. However, the Commission decided to pursue a HOV option with the same "footprint" or right-of-way requirements as a HOT lane, should there be an impetus to re-review that option in the future.

Chapter 1
INTRODUCTION

The *Santa Cruz HOT Lanes Feasibility Study (Feasibility Study)* was a cooperative study financed by the Santa Cruz Regional Transportation Commission (SCCRTC) and the Federal Highway Administration's (FHWA) Value Pricing Demonstration Program. The study included participation of Caltrans and various agencies within Santa Cruz County through the Interagency Project Review Team (IPRT).

The principal purpose of the study was to investigate the potential application of the High Occupancy Toll (HOT) lane concept on the section of Highway 1 between State Park Drive and Morrissey Boulevard. The *Feasibility Study* was conducted concurrently with the *Project Study Report (PSR)* being prepared by Caltrans, and was to help the public and decision-makers address the issues related to traffic congestion on this section of Highway 1.[3] The concurrent effort on the *Feasibility Study* and the *PSR* allowed for efficiencies in the data collection and travel demand modeling efforts, and consistency in data used for the analysis.

The *Feasibility Study* was separated into three distinct phases, with a decision point at the end of Phase 1. Phase 1 included determining whether the implementation of a HOT lane on Highway 1 in the study corridor would be physically feasible and in what configuration, whether future traffic conditions would make it financially feasible with respect to toll revenues, and what would be the HOT lane's effectiveness in managing congestion in the corridor. At the end of Phase 1, if a HOT lane is determined to be feasible and desirable for the corridor, the *Feasibility Study* would then proceed to Phase 2, which would include a detailed financial analysis, an equity/social justice analysis and a public acceptance analysis. Phase 3 would involve documentation of Phase 1 or Phases 1 and 2 if the *Feasibility Study* proceeded to Phase 2.

At the June 13, 2002 SCCRTC meeting, the Commissioners voted to not proceed with Phase 2 effort, and therefore this report presents the documentation of the Phase 1 efforts.

1.1 BACKGROUND AND OBJECTIVES

Highway 1 serves as the primary route connecting communities in the southern and central areas of Santa Cruz County. As the only continuous route through the county, Highway 1 serves as the commuter spine for trips linking Watsonville, Aptos, Capitola, Santa Cruz and the University of California at Santa Cruz. A substantial number of commuters using Highway 1 continue on State Route 17 to Santa Clara County job sites. Highway 1 is also the southern terminus for State Routes 9 and 17, both of which bring heavy tourist traffic to coastal destinations in Santa Cruz and Monterey Counties.

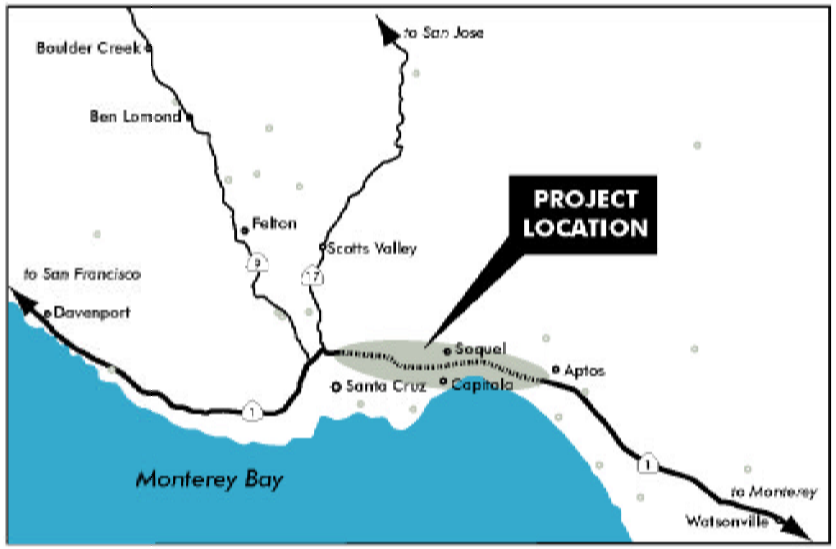
[3] The Caltrans PSR for the corridor considered a number of options to widen Highway 1, including a No Build (if nothing were to be done), and the addition of auxiliary lanes, High Occupancy Vehicle lanes, High Occupancy Toll lanes, mixed-flow lanes and operational improvements such as ramp meters.

The study corridor extends approximately 6.3 miles in Santa Cruz County between the State Park Drive/Seacliff interchange in Aptos, and the interchange of Highway 1 and Route 17 in the City of Santa Cruz. Highway 1 in this section is a four-lane divided freeway with a two- to eleven-meter median width. Within the study limits there are seven interchanges, including the freeway-to-freeway interchange with Route 17 at the northwest end of the study corridor. This interchange has non-standard design and a history of accidents, and is known locally as the "fishhook." A separate, programmed $52 million project to add merge lanes and other improvements on Highway 1 near the interchange is currently in design and is scheduled for start of construction in 2004. This study and the Caltrans *PSR* for additional Highway 1 widening assume that the Highway 1/17 merge lane project will be constructed. The study corridor is presented on Figure 1.

The widening of Highway 1 in Santa Cruz has been under consideration for a number of years and has been included in the County's Regional Transportation Plan (RTP) since 1986. In 1988, a SCCRTC study concluded that HOV lanes were feasibility on Highway 1. In 1999, the SCCRTC completed a Major Transportation Investment Study (MTIS) for the increasingly congested Watsonville/Santa Cruz/UCSC corridor of Highway 1. Following public hearings on options identified in the MTIS, the SCCRTC Board adopted a program of projects including a project to widen a segment of the highway for HOT Lanes; HOT lanes had, however, not been analyzed as part of the MTIS. Subsequently, the SCCRTC requested Caltrans to prepare a *Project Study Report* (*PSR*) for highway widening options, which could include a HOT lane project.

"HOT" lanes are designated special use lanes on an otherwise free highway facility. On HOT lanes, single-occupancy vehicles (SOVs) are charged a toll, while High Occupancy Vehicles (HOV) are allowed to use the lanes free or at a discounted toll rate. (HOV-2 indicates that there are two persons in the vehicle, while HOV-3+ indicates there are three or more persons per vehicle.) Vehicles not meeting the HOV occupancy requirements could buy the right to use the HOT lanes. The lanes are managed such that they remain uncongested at all times, including during peak hours. The HOT lane concept recognizes that a person's value of time would vary, depending on that person's purpose and urgency of the trip. Depending on the value of time, the traveler may elect to purchase their way into an uncongested facility (saving time), or, choose to remain in the free, congested general purpose lane (saving money). The HOT lane fee is directly tied to the level of congestion in the HOT lane (to ensure free-flow conditions in the HOV lane), and indirectly to the congestion in the mixed-flow (free) lanes.

Federal and State guidelines require that a major capital investment project be developed according to a prescribed protocol beginning with a statement of Purpose and Need and including identification of a range of alternatives that could address the purpose and need (see Appendix A). In addition, because HOT lanes have unique requirements related to design, operations, public acceptance and financial feasibility, evaluation in the *PSR* must be preceded by study to evaluate the feasibility of HOT lanes in the proposed segment of Highway 1. This *Santa Cruz Highway 1 HOT Lanes Feasibility Study* was conducted to determine whether a HOT lane should be included in the *PSR* for the Highway 1 widening.



NORTH
Not to Scale

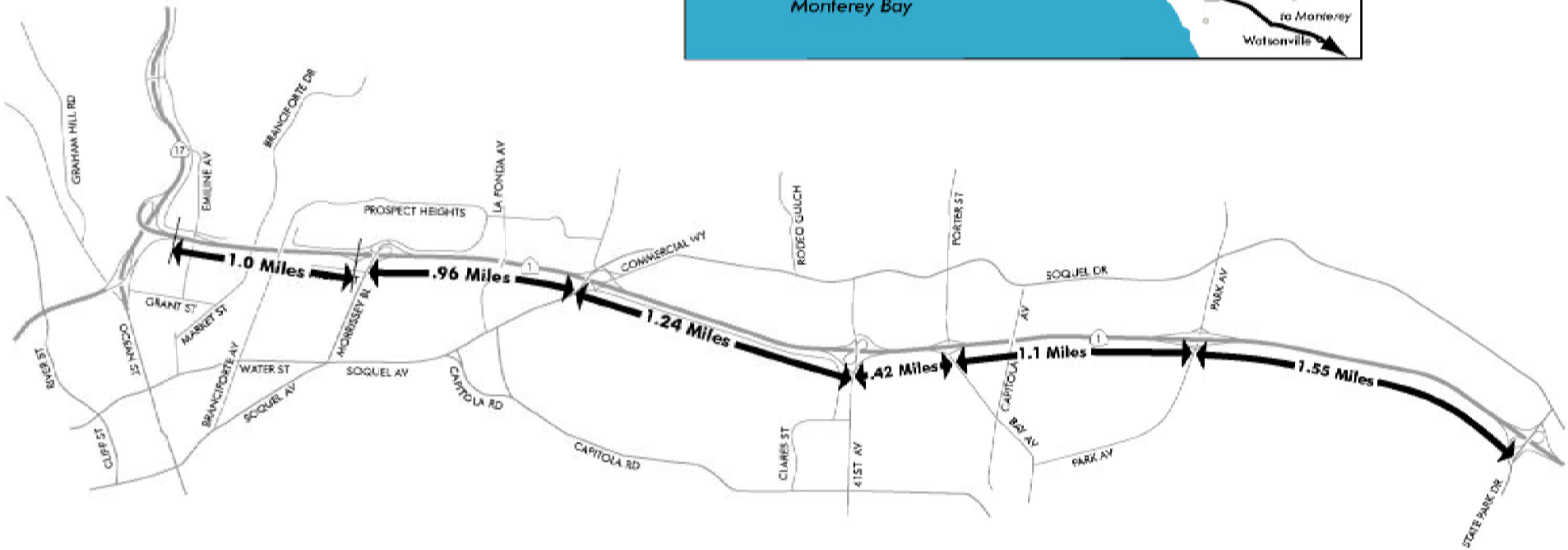


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Figure 1
STUDY CORRIDOR AND PROJECT LOCATION
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The widening of Highway 1 in the study corridor has the following Need and Purpose as identified in the *PSR*:

Purpose

Highway 1 through the study area is congested for several hours each day in both the northbound and southbound direction. There is a need to improve the operations on Highway 1 to reduce delays, travel times and accidents. The congested conditions on Highway 1 result in "spill-over' impacts to local city and county roadways and delay for local transit and express bus operations as well as emergency vehicles.

Need

The project is intended to facilitate more efficient and safe operation of Highway 1 as measured by congestion, travel times, delay and accidents. In order to encourage more efficient mobility, the project should improve travel conditions and interconnectivity for transit and high occupancy vehicles, pedestrians and bicycles.

Goals

The project should minimize impacts to the environment including noise, emissions, erosion, visual and aesthetic impacts, and impacts to biological and cultural resources, neighborhoods and disadvantaged persons.

1.2 REPORT ORGANIZATION

This report assembles the various information, findings, conclusions and lessons learned by the *Santa Cruz Highway 1 HOT Lanes Feasibility Study* project team and the IPRT. Each chapter briefly summarizes the information provided in the various technical memoranda throughout the study process. The associated technical memoranda are included in the Appendix.

The report is organized as follows. Chapter 2 describes the study approach, which includes the steps taken in the assessment of the HOT Lanes, presents the alternatives and the evaluation criteria used in the assessment, and the background information on the data collection effort conducted for the study. Chapter 3 presents the results of the preliminary screening evaluation that was conducted to narrow down the number of alternatives for detailed evaluation. Chapter 4 summarizes the detailed evaluation, including the development of future year traffic forecasts for Highway 1, incremental cost estimates, and the toll revenue analysis. Chapter 5 reviews the results of the Phase 1 effort, identifies the lessons learned, and identifies options for future consideration of HOT lanes on Highway 1.

Chapter 2
STUDY APPROACH

This chapter describes the study approach, which includes the steps taken in the assessment of the HOT lanes, presents the alternatives and the evaluation criteria used in the assessment, and the background information on the data collection effort conducted for the study. It also outlines the public participation that was part of the Phase 1 study effort.

2.1 SUMMARY OF STUDY STEPS

The *Feasibility Study* consisted of six steps:

Step 1: Existing Conditions in Study Corridor
An overview of the existing transportation characteristics and conditions in the study corridor was developed based on field surveys conducted in the spring and summer, and available data from SCCRTC and Caltrans. The data and its analysis provided the basis for analysis of the HOT lanes feasibility and served as input into the Caltrans *PSR* for the Highway 1 widening. As part of the data collection effort, a telephone survey of Santa Cruz County residents was also conducted.

Step 2: Literature Review
A literature review was conducted of the value pricing concept, existing applications of value pricing as HOT lane facilities, HOT lane studies conducted in the United States, and the primary technological issues related to HOT lanes. The information was used to understand how value pricing could be applied in the study corridor, and help refine the HOT lane alternatives as they developed.

Step 3: List of Alternatives
A preliminary list of 56 HOT lane alternative options was developed by the consultant team, the IPRT and Caltrans. These alternatives were developed based on different combinations of physical design (e.g., number of lanes, barrier versus buffer separation) and operational characteristics (e.g., permit, Electronic Toll Collection, reversible lanes).

Step 4: Evaluation Criteria
Evaluation criteria and measures of effectiveness for each criteria were developed for use in the preliminary screening of the long list of alternatives, and for the detailed evaluation. For the preliminary screening, the measures of effectiveness were qualitatively assessed. The detailed evaluation used both a quantitative and qualitative measures of effectiveness.

Step 5: Preliminary Screening Evaluation
The evaluation of the HOT lane alternatives consisted of a two-tiered effort. The first tier consisted of a preliminary screening that ruled out alternatives from further consideration. The alternatives that could not be made workable were eliminated, and the remaining alternatives

continued into the next phase of the assessment. The preliminary screening evaluation effort is presented in Chapter 3.

Step 6: Detailed Evaluation
The detailed evaluation was the second tier assessment of the HOT lane alternatives. Both quantitative and qualitative measures of effectiveness were used to assess the effectiveness and feasibility of the alternatives. An evaluation matrix was developed to assist in the assessment of each alternative. The results of the evaluation and summary of the Phase 1 were presented to the SCCRTC and to entities familiar with HOT lane operations to obtain their input. The detailed evaluation effort is presented in Chapter 4.

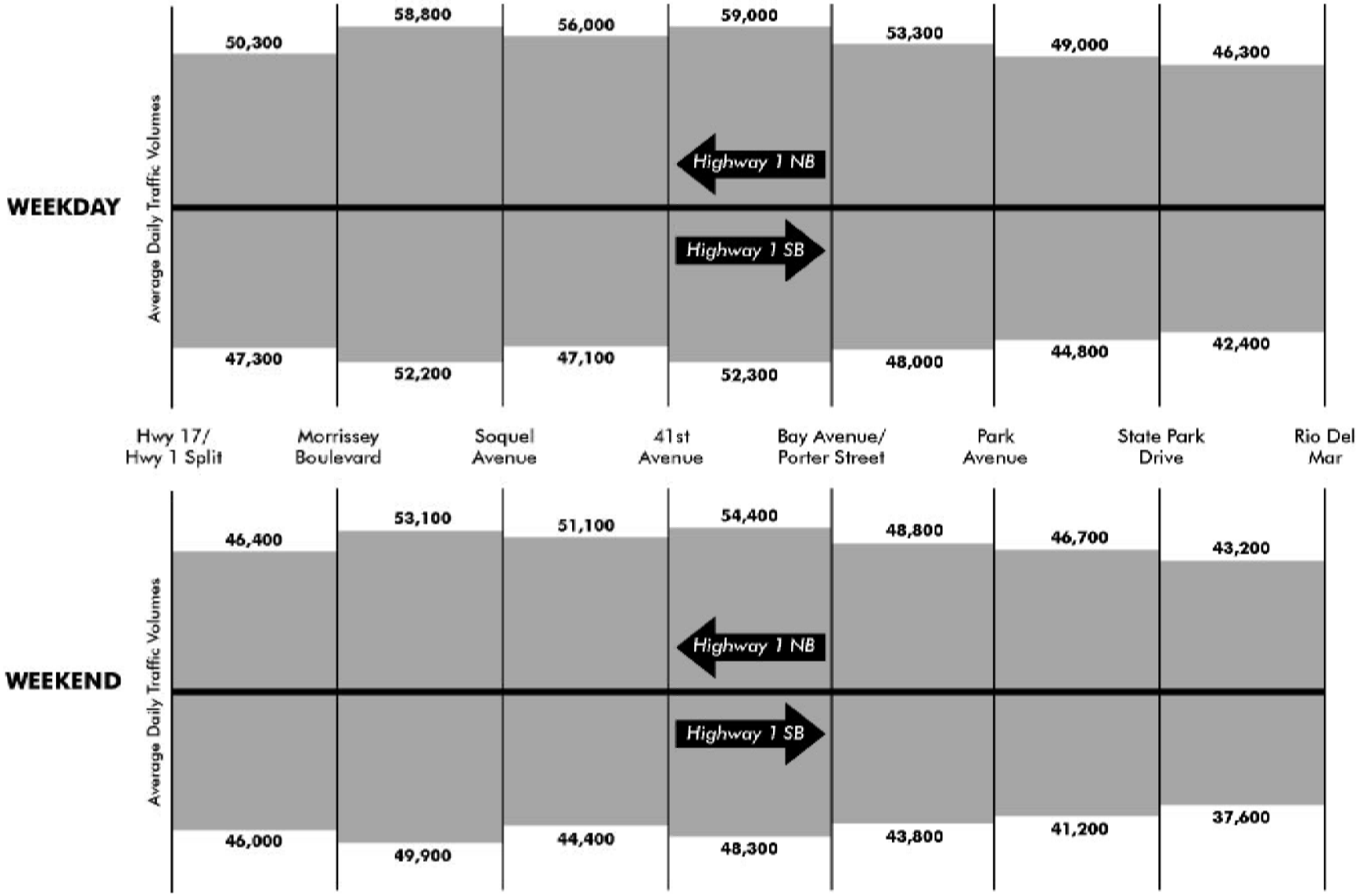
Public Participation
The public participation process during Phase 1 included the following actions: monthly IPRT meetings that were open to the public and attended regularly by a number of interested individuals, notices of IPRT meeting dates/times and topics on the SCCRTC website; three Policy Workshops[4] with SCCRTC commissioners and the public to review the *Feasibility Study* progress, and presentation of key study milestones at the televised SCCRTC meetings. Monthly status reports were included in the informational packets provided to the SCCRTC commissioners. During the IPRT, Policy Workshop and monthly SCCRTC meetings, technical memoranda and reports presenting data, analysis process and key decisions were made available to the public.

2.2 EXISTING TRANSPORTATION CONDITIONS AND TELEPHONE SURVEY

Existing transportation conditions within the Highway 1 study corridor were evaluated based on data collection conducted in the spring and summer of 2001, and existing data available from SCCRTC, Caltrans and other sources. The data collection effort included weekday and weekend traffic counts, vehicle classification and occupancy counts, and travel time and delay runs during the peak periods. The existing conditions information was summarized in a separate report and is included in Appendix B.

Figure 2 presents the weekday and weekend average daily traffic volumes for each segment of Highway 1 within the study corridor. In both the northbound and southbound directions, the highest daily traffic volumes occur between Morrissey Boulevard and Soquel Drive/Soquel Avenue interchanges and between the 41st Avenue and Bay Avenue/Porter Street interchanges. On spring weekdays, the average daily traffic volumes are about 111,000 vehicles in both of these segments, while spring weekend average daily traffic volumes are somewhat lower, at about 83,000 vehicles on the segment between 41st Avenue and Bay/Porter interchanges, and 103,000 vehicles on the segment between Morrissey Boulevard and Soquel Avenue/Soquel Drive interchanges. Daily traffic volumes are somewhat lower at the northern and southern ends of the study corridor, reflecting the use of Highway 1 for local travel/circulation.

[4] The SCCRTC's Transportation Policy Workshop is a meeting of the full Commission once a month in the SCCRTC's conference room to discuss in more detail relevant topics in an informal setting.



NOTE: Counts conducted in March and April 2001.

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Figure 2

HIGHWAY 1 WEEKDAY & WEEKEND MAINLINE AVERAGE DAILY TRAFFIC VOLUMES

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During the weekday AM and PM peak periods, about 98 percent of the vehicles are autos and about two percent trucks. While buses do travel on Highway 1 in the study corridor, they represent less than one percent of the total traffic. For autos traveling on Highway 1, the percentage of single-occupant vehicle traffic during the AM and PM peak periods ranges from 77 to 89 percent, vehicles in the HOV 2 category ranges from 10 to 20 percent, and the HOV 3+ category ranges between 1 and 4 percent.

A telephone survey of 400 residents of Santa Cruz County that are users of Highway 1 was conducted in May 2001 to obtain an understanding of the current users of Highway 1. The results of the survey, in conjunction with output from the AMBAG regional travel demand model, were used to assess the number of vehicle trips that could potentially use a HOT lane. Information that was obtained from the survey included: origin and destination patterns, trip purpose, frequency of trips, users of Highway 1 versus local streets, and demographics of Highway 1 corridor users. Results of the telephone survey are presented in the Existing Conditions report included in Appendix B.

2.3 LITERATURE REVIEW

A literature review was conducted of the value pricing concept and high occupancy toll lane application, as well as examples of existing HOT lane projects and ongoing studies. This effort is summarized in the memorandum in Appendix C. The information was presented to the IPRT and the SCCRTC.

There are three examples of the HOT lane concept in the United States – on SR 91 and I-15 in California, and on the I-10 in Texas. None were built originally as HOT lanes; SR 91 is a private toll road that utilizes variable pricing strategies, the I-15 Express Lanes were underutilized HOV lanes that were converted to HOT Lanes, and the I-10 lanes implemented variable pricing onto the HOV lane to reduce the traffic volumes in the HOV lane in order to maintain free-flow conditions.

- **SR 91 "Express Lanes" in Orange County, California** – This 10-mile long privately funded and managed toll facility opened in December 1995. It consists of the four inside lanes of a freeway corridor, two in each direction, which are separated by a pyloned buffer from adjacent lanes. There are no entrances or exits to the Express Lanes other than at the end points. Fees are collected via electronic toll collectors (ETC). HOVs with three or more occupants were allowed to travel for free from the opening of the facility until January 1998, when a half-price charge was instituted. This project is the first fully electronic and automated toll road in the U.S.

  In April 2002, the Orange County Transportation Authority reached an agreement with the California Private Transportation Company (which owned the SR 91 Toll Road) to purchase the SR 91 Express Lanes Toll Road and operational franchise agreement for $207 million. The purchase would allow for public ownership, adjustment of the toll rates to maximize throughput (rather than profits), and pave the way for other SR 91 freeway improvements by eliminating the franchise's "non-compete agreement".

- **I-15 Express Lanes in San Diego, California –** In December 1996, an existing 8-mile, underutilized 2-lane reversible (barrier-separated) HOV facility was converted to HOT lanes. HOVs with two or more occupants are allowed to travel for free. There are no entrances or exits to the HOT lanes other than at the end points. This project was initiated with permits, and electronic tolling was implemented one year later. The facility has a variable pricing structure, where tolls vary in response to changing congestion levels.

  The San Diego Council of Governments (SANDAG) has recently completed a feasibility study that evaluated the extension of the reversible I-15 HOV/HOT lane, including multiple access points to the regular highway lanes, direct access ramps for buses, as well as other improvements such as park-and-ride facilities and transit service. The I-15 Managed Lanes Project has been approved by Caltrans and SANDAG, and the first phase of the project will be open to traffic in 2004.

- **Katy Freeway (I-10), Houston, Texas –** Similar to the San Diego program, in January 1998 the Metropolitan Transit Authority and Texas Department of Transportation (TXDOT) modified a 13-mile reversible (barrier-separated) HOV lane on the Katy Freeway to two-person carpools for a fee during the most heavily congested AM and PM peak periods. During the remainder of the day HOV 2+ vehicles could access the lane for free. Ingress and egress are at either end of the HOV lane. This action was taken to reduce traffic on the HOV lane due to overcrowding of carpools. Fees are collected via ETC. HOVs with three or more occupants are allowed to travel for free, while HOVs with two occupants pay a fee. Single occupant vehicles are not permitted to use the lane.

There are a number of completed and ongoing feasibility studies of HOT lanes and other road pricing studies throughout the United States, including in Colorado, California, Texas, Washington, Maryland, Florida, North Carolina, New Jersey, Pennsylvania and Oregon.

A separate memorandum was prepared presenting the major design and technology issues associated with HOT lanes. Issues that were reviewed included: design (lane separation, access, signage and toll readers, enforcement areas), toll collection (permit system, Electronic Toll Collection (ETC) system, HOVs versus Single Occupant Vehicles (SOV) in lane, enforcement) and the three basic pricing options. The HOT Lane Concept Design and Technology Review memorandum is included here as Appendix D.

2.4 EVALUATION CRITERIA

To assist in the evaluation of the alternatives in both the preliminary screening and detailed evaluation efforts, a set of evaluation criteria was developed. For each of the evaluation criteria, measures of effectiveness were developed and are detailed in Appendix E. Six categories of evaluation criteria were used:

- Engineering Design – This criteria compares the HOT lane's feasibility for incorporation into the existing roadway right-of-way, and compatibility with corridor overcrossings, roadway geometry and design features that could adversely affect operation and safety.

Measures of effectiveness included compatibility with design standards, safety, enforcement, tolling feasibility and maintenance issues.

- Benefit/Ability to Solve Problem – The operational impacts of the alternatives were evaluated for future conditions. Measures of effectiveness included ability to provide congestion relief, travel time savings, enhancement of HOV and transit on Highway 1, and meeting the Highway 1 widening project's purpose and need.
- Cost Factors – Measures of effectiveness included incremental capital, operation and maintenance costs, projected revenues and profit.
- Environmental – Each alternative was reviewed for evidence of substantial environmental impacts.
- Socio-economic – Although some alternatives could be accommodated within the right-of-way proposed for the Highway 1 widening, additional right-of-way would be required in order to maintain design standards or accommodate a specific feature of an alternative. Right-of-way impacts were identified, as appropriate.

  In addition to considering who will receive the benefits of the HOT lanes with respect to traffic operations (e.g., HOT lane users only, all traffic on Highway 1, transit users), potential equity issues also include the geographical and income distribution of those that would use the toll lanes and the distribution of benefits among the users.
- Deliverability – Factors that relate to deliverability include the ease with which an alternative can be implemented, the degree of public support, potential environmental impacts, and financial feasibility.

2.5 LIST OF ALTERNATIVES

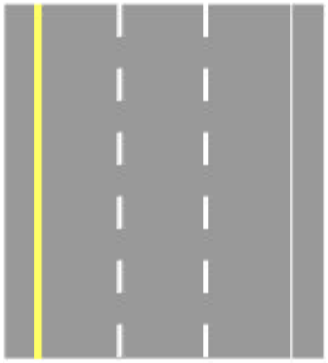
A list of 56 HOT lane alternative options was developed in May and June of 2001 by the consultant team and Caltrans, and was presented to the IPRT on May 31, 2001 and to the RTC on June 7, 2001. (See Appendix F) These alternatives were developed based on different physical and operational characteristics, and all assumed that one additional lane would be provided on Highway 1 in both the southbound and northbound directions. Due to the currently oversaturated conditions and anticipated growth in traffic volumes in the corridor, conversion of an existing mixed-flow lane to a HOT lane was not considered. Included in the list of alternatives were three different lane configurations (one lane in each direction, one reversible lane, and two reversible lanes), three lane-separation options (barrier, buffer and striped), the potential for direction HOV/HOT connectors between Highway 1 and Highway 17, two toll collection methodologies (electronic toll collection "ETC" and permit), and three intermediate access possibilities (none, one or two, and continuous). The three lane separation options considered are presented in Figure 3.

The initial list of 56 alternative options is presented in Table 1. During the preliminary screening, these alternatives were subject to various levels of assessment to identify alternatives that would not be feasible due to an obvious fatal flaw associated with design, operational or

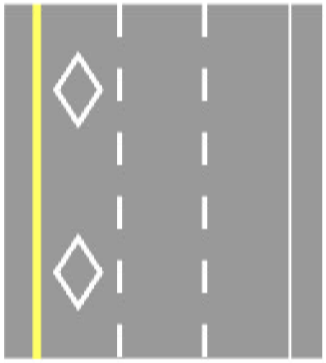
safety issues. Five alternatives that remained following the preliminary screening were subject to a detailed evaluation.

These five alternatives include:

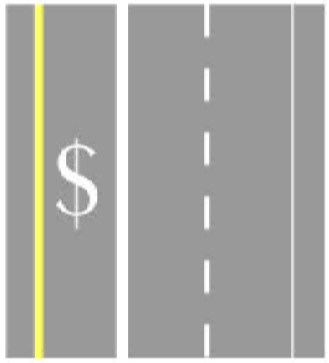
- Alternative 1A – one lane in each direction with barrier separation, no intermediate access
- Alternative 2A – one lane in each direction with buffer separation, no intermediate access
- Alternative 3B – one lane in each direction with striped separation, 1 intermediate access point. Highway 1 between 41st and Soquel Avenues was determined to be the only segment in the project limits that contains sufficient length for the weaving section necessary for vehicles to enter and exit the HOT lane at an intermediate access location.
- Alternative 3C – one lane in each direction with striped separation, continuous access
- Alternative 4A – one reversible lane with barrier separation, no intermediate access



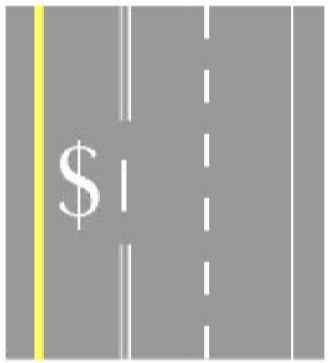
Mixed FLow Lane



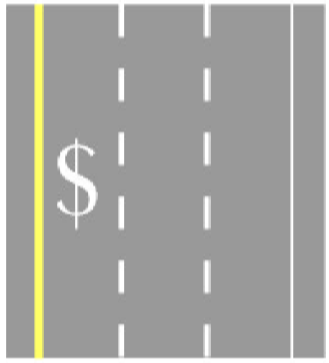
HOV Lane



HOT Lane
Barrier or Buffer Separated



HOT Lane
Striped Separation
One Intermediate Access



HOT Lane
Continuous Access

Table 1
Initial List of Alternatives

#	Configuration	Lane Separation	H1/H17 Connectors	Toll	Intermediate Access
1A	One lane	Barrier	No	ETC	None
1B	One lane	Barrier	No	ETC	1 or 2
1C	One lane	Barrier	No	Permit	None
1D	One lane	Barrier	No	Permit	1 or 2
1E	One lane	Barrier	Yes	ETC	None
1F	One lane	Barrier	Yes	ETC	1 or 2
1G	One lane	Barrier	Yes	Permit	None
1H	One lane	Barrier	Yes	Permit	1 or 2
2A	One lane	Buffer	No	ETC	None
2B	One lane	Buffer	No	ETC	1 or 2
2C	One lane	Buffer	No	Permit	None
2D	One lane	Buffer	No	Permit	1 or 2
2E	One lane	Buffer	Yes	ETC	None
2F	One lane	Buffer	Yes	ETC	1 or 2
2G	One lane	Buffer	Yes	Permit	None
2H	One lane	Buffer	Yes	Permit	1 or 2
3A	One lane	Striped	No	ETC	None
3B	One lane	Striped	No	ETC	1 or 2
3C	One lane	Striped	No	ETC	Continuous
3D	One lane	Striped	No	Permit	None
3E	One lane	Striped	No	Permit	1 or 2
3F	One lane	Striped	No	Permit	Continuous
3G	One lane	Striped	Yes	ETC	None
3H	One lane	Striped	Yes	ETC	1 or 2
3I	One lane	Striped	Yes	ETC	Continuous
3J	One lane	Striped	Yes	Permit	None
3K	One lane	Striped	Yes	Permit	1 or 2
3L	One lane	Striped	Yes	Permit	Continuous
4A	Reversible - One lane	Barrier	No	ETC	None
4B	Reversible - One lane	Barrier	No	ETC	1 or 2
4C	Reversible - One lane	Barrier	No	Permit	None
4D	Reversible - One lane	Barrier	No	Permit	1 or 2
5A	Reversible - One lane	Buffer	No	ETC	None
5B	Reversible - One lane	Buffer	No	ETC	1 or 2
5C	Reversible - One lane	Buffer	No	Permit	None
5D	Reversible - One lane	Buffer	No	Permit	1 or 2
6A	Reversible - One lane	Striped	No	ETC	None
6B	Reversible - One lane	Striped	No	ETC	1 or 2
6C	Reversible - One lane	Striped	No	ETC	Continuous
6D	Reversible - One lane	Striped	No	Permit	None
6E	Reversible - One lane	Striped	No	Permit	1 or 2
6F	Reversible - One lane	Striped	No	Permit	Continuous
7A	Reversible - Two lane	Barrier	No	ETC	None
7B	Reversible - Two lane	Barrier	No	ETC	1 or 2
7C	Reversible - Two lane	Barrier	No	Permit	None
7D	Reversible - Two lane	Barrier	No	Permit	1 or 2
8A	Reversible - Two lane	Buffer	No	ETC	None
8B	Reversible - Two lane	Buffer	No	ETC	1 or 2
8C	Reversible - Two lane	Buffer	No	Permit	None
8D	Reversible - Two lane	Buffer	No	Permit	1 or 2
9A	Reversible - Two lane	Striped	No	ETC	None
9B	Reversible - Two lane	Striped	No	ETC	1 or 2
9C	Reversible - Two lane	Striped	No	ETC	Continuous
9D	Reversible - Two lane	Striped	No	Permit	None
9E	Reversible - Two lane	Striped	No	Permit	1 or 2
9F	Reversible - Two lane	Striped	No	Permit	Continuous

Chapter 3
PRELIMINARY SCREENING EVALUATION

The preliminary screening evaluation consisted of a two-step effort; a pre-screening evaluation was conducted prior to the screening evaluation. The pre-screening evaluation was to identify any potential fatal flaws or deficiencies associated with the 56 alternatives listed in Table 1 in Section 2.5. This pre-screening effort reduced the number from the initial list of 56 to seven. The remaining seven alternatives were then subject to a preliminary screening to determine their relative strengths and weaknesses. The screening evaluation consisted of a qualitative assessment of how each alternative would perform with respect to design considerations and the ability to address the traffic congestion in the corridor. See Appendix G. A key element of the screening evaluation was a design analysis, which was conducted by Caltrans in consultation with the consultant team. As part of the analysis typical sections, right of way impacts, requirements for transitional areas and weaving sections were developed.

A screening matrix of the seven alternatives and the measures of effectiveness was developed to assess the performance of the alternatives. Alternatives that received a ranking of "0" for any measure of effectiveness were assumed to have a fatal flaw and were dropped from further consideration. Based on the screening evaluation, the seven HOT lane alternatives were reduced to five, which were then recommended for detailed evaluation. These alternatives were approved at a televised SCCRTC meeting, and include:

- Alternative 1A – one lane in each direction with barrier separation, no intermediate access
- Alternative 2A – one lane in each direction with buffer separation, no intermediate access
- Alternative 3B – one lane in each direction with striped separation, 1 intermediate access point between 41st and Soquel Avenues
- Alternative 3C – one lane in each direction with striped separation, continuous access
- Alternative 4A – one reversible lane with barrier separation, no intermediate access

The preliminary screening effort resulted in a set of attributes that are common to each of the HOT lane alternatives:

- A HOT lane approximately five miles in length between State Park and Park on the southern end, and near Morrissey Avenue on the northern end.
- Variable pricing by time of day and congestion levels would maintain optimal traffic flow in the HOT lanes and provide the most efficient tolling strategy.
- Electronic toll readers together with on-board vehicle transponders would be the preferred method for charging HOT lane customers.
- Vehicles with two or more occupants (HOV 2+) would not be tolled.
- A median enforcement area would not be provided due to right-of-way constraints.

Chapter 4
DETAILED EVALUATION

This chapter summarizes the detailed evaluation, including the development of future year traffic forecasts for Highway 1, incremental cost estimates, and the toll revenue analysis.

4.1 TRAVEL DEMAND FORECASTS

Future year 2020 travel demand forecasts were developed by Caltrans for use in both the *Highway 1 HOT Lanes Feasibility Study* and for the *Highway 1 Widening PSR* that was concurrently being prepared by Caltrans. Year 2020 was selected as the future analysis year, as it represents the year nearest the anticipated implementation date for which travel demand forecasts were available. Travel demand forecasts were prepared using the Association of Monterey Bay Area Governments (AMBAG) travel demand model using output for 2000 and 2020 conditions, and validated by Caltrans using traffic data collected on Highway 1 in the spring and summer of 2001. The travel demand model includes freeways and local streets, and considers the available capacity, travel demand and travel speeds in assigning the future travel demand to the roadway network. (See Appendix H)

Travel demand projections from the AMBAG model were based on employment and population projections from the *1997 Regional Population and Employment Forecasts for Monterey, San Benito, and Santa Cruz Counties* (AMBAG). Between years 2000 and 2020, the population in the three-county area is projected to increase by 30 percent (from 708,800 to 920,900 residents), and employment is projected to increase by 22 percent (from 290,200 to 353,700 jobs). The majority of the growth is anticipated to occur in Monterey County, however, growth in Santa Cruz County represents 22 percent of the increase in population (about 44,900 residents), and 39 percent of the increase in employment (24,100 jobs). It should be noted that updates to the regional population and employment forecasts (scheduled for 2003) may change the growth projections, which may potentially change the traffic analysis and conclusions reached in this study. Minor changes in population and employment forecasts would not substantially change the traffic analysis and conclusions reached in this study.

Traffic volumes were developed for year 2020 conditions for the on- and off-ramps and mainline segments for the study corridor assuming implementation of an additional lane on Highway 1 between State Park and Morrissey Avenue. Weekday traffic volumes were developed for a 24-hour period for 15-minute increments. For use in the *Feasibility Study*, the traffic volumes for the 15-minute intervals were reviewed to determine the periods to be used for the traffic and revenue analysis. The periods developed for the analysis were defined as follows:

- AM Peak – 7:00 to 9:00 AM
- AM Shoulder – 9:00 to 10:00 AM
- Midday – 10:00 AM to 2:00 PM
- PM Shoulder 1 – 2:00 to 3:00 PM

- PM Peak – 3:00 to 6:00 PM
- PM Shoulder 2 – 6:00 to 7:00 PM

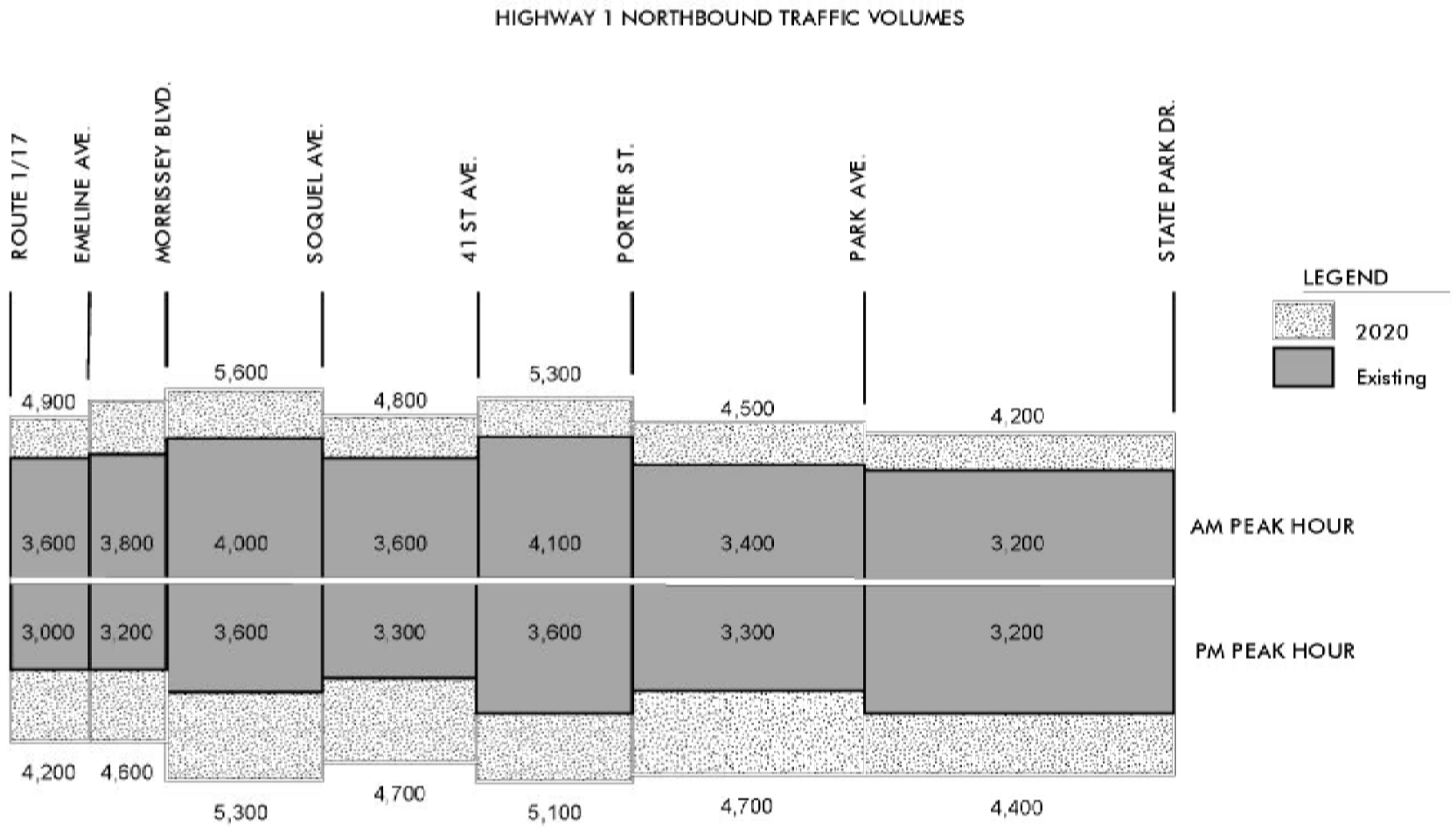
The 15-minute traffic volumes were aggregated into the periods to develop demand volumes for each ramp and mainline segment for each interval. The demand volumes for each interval were then divided by the number of hours represented by each period to develop an average hourly volume for the period to be used in the traffic and revenue analysis. Table 2 presents the year 2020 average hour traffic volumes on the section of Highway 1 between the Morrissey and Soquel interchanges. Figures 4A and 4B present the peak hour traffic volumes on Highway 1 for Existing and 2020 conditions.

In order to analyze the three different HOT lane project configurations – no intermediate access, one intermediate access, and continuous access – it was necessary to identify travel movements in the corridor that are eligible to use the HOT lanes based on the entry and exit points to the HOT lanes. Eligible traffic is defined as trips that travel from a location upstream of the HOT lane entry point to a location downstream of the HOT lane exit point. For the no intermediate access scenario, the only eligible movements for the project are "through" trips, the trips that travel the entire length of the HOT lane, which extends from Morrissey Boulevard to between Park Avenue and State Park Drive. Matrices representing all interchange-to-interchange travel in the study area were developed from the AMBAG travel demand model output.

Table 2
Summary of Average Hour Traffic Volumes
Highway 1 between Morrissey Boulevard and Soquel Avenue Interchanges
2020 Conditions

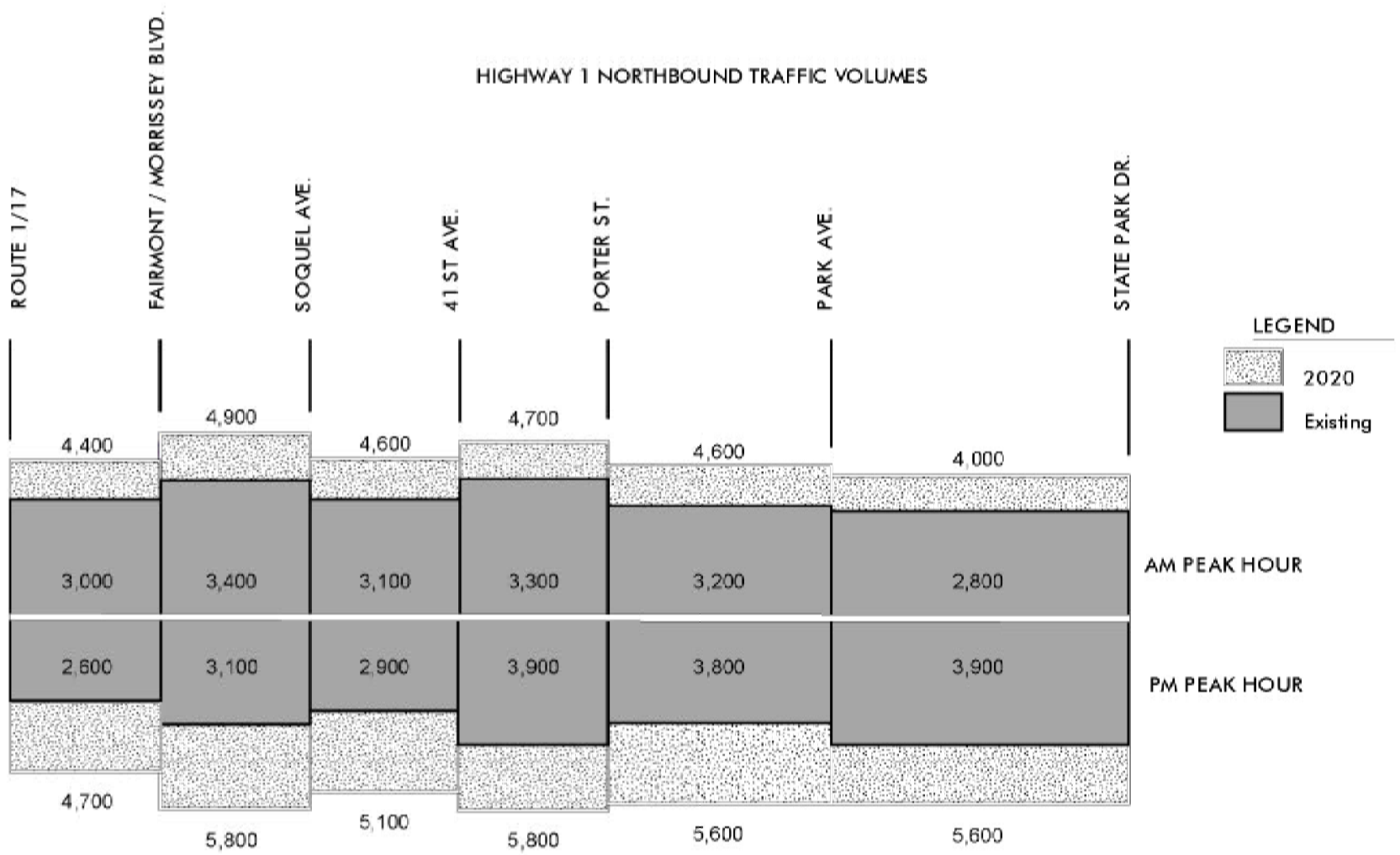
Analysis Periods	Northbound	Southbound
AM Peak – 7:00 to 9:00 AM	5,290	4,500
AM Shoulder – 9:00 to 10:00 AM	4,140	4,110
Midday – 10:00 AM to 2:00 PM	3,860	4,470
PM Shoulder 1 – 2:00 to 3:00 PM	4,440	4,800
PM Peak – 3:00 to 6:00 PM	4,920	5,320
PM Shoulder 2 – 6:00 to 7:00 PM	4,570	4,450

Source: Wilbur Smith Associates – April 2002



ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

Figure 4A
EXISTING AND 2020 PEAK HOUR TRAFFIC VOLUMES - NORTHBOUND



ENGINEERS
PLANNERS
ECONOMISTS
Wilbur Smith Associates

Figure 4B
EXISTING AND 2020 PEAK HOUR TRAFFIC VOLUMES - SOUTHBOUND
360430\Reports\Evaluation Report - Draft 1\Main Report\Graphics\EX Volumes-8/29/02

As part of the Caltrans *PSR* analysis, an operational analysis was conducted for the study corridor using the year 2020 traffic volume forecasts for the No Build and Build options. In the northbound, the operational analysis indicated that the Highway 1/17 interchange, in particular the fishhook ramp for the Highway 1 through movement, would be the primary bottleneck in the corridor. The operational analysis for the HOT lane *Feasibility Study* incorporated this bottleneck and its impacts on the HOT lane into the operation profile for the corridor.

In the southbound direction, the provision of an additional lane between Morrissey Boulevard and State Park Drive would result in a bottleneck at the southern terminus of the project (where the additional lane ends and the highway continues in its currently configured two-lanes), which would result in significant congestion upstream of the bottleneck in the three lane segment. Alternative southern termini were analyzed to determine whether this new bottleneck could be eliminated. Testing of alternative termini options indicated that with the continuation of the additional travel lane to Larkin Valley/San Andreas Road (south of which the freeway widens to three lanes) would substantially reduce congestion throughout the study corridor in the southbound direction. Discussion of this alternative southern project limit was included in the *Project Study Report* and will be further evaluated in the *Project Approval/Environmental Document (PA/ED)* phase of the Highway 1 Widening/HOV project.

The *Feasibility Study* and subsequent discussion of the HOT lane assumes that the southern terminus of the Highway 1 widening is at State Park Drive, with the associated bottleneck where the three lanes would merge down to the two-lane section of the highway. Extension of the additional lane to Larkin Valley/San Andreas Road would reduce or eliminate congestion within the study corridor in the southbound direction, and thereby reduce or eliminate any travel time benefits of a HOT lane.

4.2 TOLL REVENUE ANALYSIS

To analyze the performance of the five HOT lane alternatives, a technique was developed that integrated three traffic analysis models:

- a traditional macroscopic travel demand model to estimate global traffic demand on Highway 1, and interchange-to-interchange trip tables for the study corridor;
- a FREQ traffic simulation model to develop an operational profile of the corridor;
- and a market share micromodel to estimate traffic levels likely to pay a toll under different pricing and time-savings conditions.

This toll revenue analysis effort was substantive and provided the bulk of data for the detailed evaluation. The toll revenue analysis is detailed in Appendix I. The micromodel analysis is briefly described below.

The micromodel for the corridor involved integrating the input data developed from the travel demand model and the operational profile of the corridor with other assumptions that would determine the willingness of drivers to pay tolls. Variables that were used to determine the willingness to pay tolls include the average value of time for drivers based on 1990 Census data, the toll charged, and the time savings offered based on the operational profile of the corridor.

The micromodel for the corridor used the interchange-to-interchange matrices developed from the AMBAG model output as origins and destinations. Eligible trips were identified for each alternative, and the travel time in the mixed-use lanes and in the HOT lane were compared for each eligible movement. The time savings were compared to the toll rates charged for the period, and a level of diversion was estimated.

The micromodel was run through an equilibrium process to determine the level of diversion for a given toll rate level. A range of toll rates was tested in order to determine the revenue-maximizing level. Once the revenue-maximizing toll level was identified, traffic in the HOT lane was checked to ensure that it would not exceed 1,600 vehicles per hour, which is considered the operational maximum flow to ensure freeflow conditions. If at the revenue-maximizing toll rate the total traffic in the HOT lane was found to exceed 1,600 vehicles per hour, then a higher toll rate that limited demand to 1,600 vehicles per hour was chosen.

The micromodel analyzed SOV, HOV-2, and HOV-3+ traffic for each eligible movement individually. Consistent with the Caltrans *PSR* assumption for the HOV lane (which assumes a HOV 2+ lane) HOV-2 and HOV-3+ traffic was assumed to use the HOT lane free of charge in all scenarios. Approximately 90 percent of all eligible HOV traffic was assigned to the HOT lane during the equilibration process. Overall, the greatest level of time savings is in the peak direction during peak periods. Time savings for other time periods is typically less than 3 minutes. Time savings during the peaks often exceeds 10 minutes.

Table 3 shows the distribution of peak period traffic between the HOT lane and the general purpose lanes under the three alternative access configurations, for the segment of Highway 1 between Morrissey Avenue and Soquel Avenue. It also shows the amount of free (i.e., HOV) and tolled traffic assumed to be in the HOT lane.

Table 3
Summary of Hourly Volumes on Highway 1 between Morrissey and Soquel Interchanges
2020 Conditions, Three Access Configurations

Access Configuration/ Time Period/Direction	Average Hourly Traffic Volumes					
	HOT Lane				Mixed Flow Lanes	Total Demand
	SOV	HOV 2	HOV 3+	Total		
No Intermediate Access						
Southbound						
AM	110	433	60	60.	3,899	4,502
PM	556	581	63	1,200	4,120	5,320
Northbound						
AM	386	450	64	900	4,386	5,286
PM	287	395	48	730	4,191	4,921
One Intermediate Access						
Southbound						
AM	14	741	111	866	3,636	4,502
PM	750	832	89	1,671	3,649	5,320
Northbound						
AM	355	832	128	1,315	3.971	5,286
PM	142	698	94	934	3,987	4,921
Continuous Access						
Southbound						
AM	0	925	142	1,068	3,434	4,502
PM	142	1,055	121	1,318	4,002	5,320
Northbound						
AM	348	1,025	158	1,531	3,755	5,286
PM	8	713	96	817	4,104	4,921

Source: Wilbur Smith Associates – April 2002

As indicated above, the toll rate selected was that which would result in the highest revenue while effectively managing the travel demand and congestion in the HOT lane (about 1,600 to 1,700 vehicles per hour). Toll rates generally ranged between $0.50 and $2.50, with the highest toll of $4.00 under Alternative 3C (continuous access) during the PM peak period in the southbound direction. The use of lower tolls, which may be more practical or politically feasible, would result in a greater throughput on the HOT lane and lower revenue estimates.

Weekday daytime revenues were developed for year 2020 conditions for each of the six time periods. The total daytime revenue was factored to account for reduced overnight and weekend use of the HOT lane. The weekday and weekend revenues were multiplied by the number of days in a year to obtain the annual toll revenues. The resulting number of daily tolled vehicles and the annual toll revenues are presented on Table 4. In the event that Highway 1 would not be tolled during the weekends, the annual toll revenues presented on Table 4 would be about 20 percent lower, except for Alternative 4A which would be about 10 percent lower (since would only serve one direction at a time).

Table 4 Summary of HOT Lane Alternatives Toll Revenues 2020 Conditions, First Year Revenues		
HOT Lane Alternative	**Daily SOV (Tolled) Volumes**	**Annual Toll Revenues (2002$)**
1A – Barrier	6,100	$3,028,000
2A – Buffer	6,100	$3,028,000
3B – Striped, 1 access	8,100	$2,903,000
3C – Striped, continuous	6,300	$2,156,000
4A – Reversible	3,700	$2,039,000

Source: Wilbur Smith Associates – April 2002

Alternatives 1A (barrier) and 2A (buffer), which both assume no intermediate access, would generate approximately $3.0 million per year in toll revenue, while Alternative 3B (one intermediate access) would generate slightly less revenue annually, at $2.9 million per year. Alternative 3B (reversible) would also have the greatest number of daily single occupant tolled vehicles.

The continuous access scenario, Alternative 3C, is estimated to generate $2.2 million in toll revenue annually. This lower level of revenue is due to the increase in HOV traffic in the HOT lane when additional access locations are added. The lowest revenue scenario is Alternative 4A (reversible), which would generate $2.0 million. The reversible lane scenario is able to generate more than half the revenue than the others since it would be open in the peak direction during peak periods, when most of the revenue is generated.

4.3 COSTS ESTIMATES

In developing the project costs, the HOT lane analysis assumed that Highway 1 would be widened by one additional lane in each direction. The ***incremental*** costs associated with construction and operation/maintenance of the HOT lane (i.e., additional costs over and above the capital costs for widening Highway 1 by one additional lane in each direction, as well as the annual maintenance costs) were developed for each of the five alternatives. These HOT lane costs were prepared based on the methodology and unit costs used by Caltrans to develop project costs for the *Highway 1 Widening PSR*. See Appendix J.

Preliminary cost estimates for the five Highway 1 HOT lane alternatives that remained following the screening evaluation were developed by Parsons Brinckerhoff Quade and Douglas. The costs are planning level costs only, and would be refined based on the final design of the selected alternative. The purpose of these preliminary cost estimates is to allow for a relative comparison of the costs for each alternative. These costs would also be compared to the estimated revenues generated by each alternative.

Capital Costs

Capital costs include the additional costs associated with the additional right-of-way, roadway pavement and impact on structures (depending on alternative), as well as the system costs such as the automatic vehicle identification (AVI) system used for toll collection, changeable message signs, fiber optic cables to carry data, a central control room, vehicle transponders and other miscellaneous items. As indicated in Table 5, the incremental capital costs range between a minimal $2.4 million for the striped separation Alternatives 3B and 3C, which do not require additional right-of-way or reconstruction of bridge structures beyond what would be required for the HOV widening, to $21 million for Alternatives 1A and 2A which require additional right-of-way.

Operations and Maintenance Costs

The operations and maintenance (O&M) costs include those costs associated with operating a HOT lane, and include replacement, operations, maintenance, enforcement and marketing costs. These costs were estimated from experience from other toll road projects.

Replacement costs include items such as computers, AVI equipment, pylons, personal transponders, etc. These are the items that are expected to wear out or become obsolete over the life of the toll lanes. Operations costs include the enforcement and tolling operations, including staff and special equipment needed by the staff. Maintenance costs for the toll lanes include those items particular to this project that do not fall under normal Caltrans roadway maintenance, such as the AVI equipment, transponders and the computers. Marketing costs are yearly costs to keep the public aware of the toll lanes. The estimate assumes a higher marketing cost for the first two years, and then a constant lower cost for subsequent years. O&M costs vary per year due to the different levels of maintenance as the facility ages. Therefore, the O&M costs have been amortized and converted into a yearly present worth. This means, for example, that the cost for replacing computers in five years has been partly included in the O&M cost for each of the first five years. The incremental O&M costs range between $600,000 and $1.3 million, and include increased enforcement requirements for the HOT lane.

Table 5 presents a comparison of the incremental costs for capital and operations and maintenance costs for each of the five HOT lane alternatives.

Table 5 Summary of Incremental Project Costs for HOT Lane Alternatives (000s, 2002$)[1]						
HOT Lane Alternative	**Capital**			**Operations & Maintenance (per year)**		
	Roadway[2]	**System**[3]	***Total***	**Roadway**[2]	**System**[3]	***Total***
1A – Barrier	$19,000	$2,045	*$21,045*		$598	*$598*
2A – Buffer	$14,500	$2,045	*$16,545*	$735	$598	*$1,333*
3B – Striped, 1 access	--	$2,338	*$2,338*		$618	*$618*
3C – Striped, continuous	--	$2,446	*$2,446*		$968	*$968*
4A – Reversible	$17,500	$2,035	*$19,535*	$750	$588	*$1,338*

Source: Parsons Brinckerhoff, Wilbur Smith Associates – March 2002

Notes:

[1] Incremental costs associated with constructing and implementing the HOT lane alternative were developed assuming that Highway 1 in the project area would be widened by one additional lane in each direction.

[2] Roadway costs include roadway, structure and right-of-way costs.

[3] System costs include those costs associated with implementing the HOT lane concept.

4.4 COMPARISON OF ALTERNATIVES

The detailed evaluation consisted of a quantitative and qualitative assessment of how each alternative would perform with respect to the six evaluation criteria and the 18 measures of effectiveness. (See Appendix K) A detailed evaluation matrix was developed by the consultant team and the Interagency Project Review Team (IPRT) to assist in the assessment of the alternatives. To the extent possible, the ratings of the measures of effectiveness were based on quantitative assessments of the HOT lane with respect to vehicles, costs, revenues and travel time savings. This summary matrix is presented in Figure 5. It should be noted that during the detailed evaluation of the HOT lane alternatives and the analysis of the Highway 1 widening by Caltrans, a comparison of an additional HOV lane to the HOT lane was conducted to determine the benefits of a HOT lane over an HOV lane. The HOV lane would be constructed within the median of Highway 1 for the same project limits as the HOT lane analyzed in this study. For this reason, an HOV lane, while not explicitly analyzed in the *Feasibility Study*, is included in the evaluation matrix as a base case for comparison.

Table 6 presents an estimate of the annual net income generated by each HOT lane alternative. Net revenue represents the amount of money available to pay for the incremental capital costs associated with the HOT lane, to pay for the capital costs of an HOV lane, or to fund other projects, such as transit improvements in the corridor. Due primarily to the low incremental operations and maintenance costs, Alternative 1A (barrier) and Alternative 3B (one intermediate access) are projected to have the greatest annual net income of the alternatives, at more than $2.0 million per year. Alternative 2A (buffer), which has high incremental operations and maintenance costs, and Alternative 3C (continuous access) which has the second lowest annual toll revenue and high incremental operations and maintenance costs, would have revenues of about $1.7 and $1.1 million, respectively. Alternative 4A (reversible), which would only collect

Figure 5
Detailed Evaluation Matrix

	Alt. 1A Barrier	Alt. 2A Buffer	Alt. 3B One Access	Alt. 3C Continuous	Alt. 4A Reversible	HOV Lane (1)
Design Considerations						
Meets Standards	◔	◕	◔	◔	◔	○
Safety	◔	◕	◔	◔	◔	◔
Enforcement	○	◔	◕	◕	○	◕
Tolling Feasibility	○	○	◔	◕	○	n/a
Maintenance	◔	◕	○	○	◕	○
Address Problem						
Congestion Relief (2)(3)	◔	◔	○	○	◕	○
Travel Time Savings (2)(4)	◔	◔	○	◔	◕	○
Enhance HOV/Transit	◕	◕	◔	○	◕	○
Purpose & Need	◔	◔	○	○	◕	○
Cost Factors						
Construction (2)	◕	◔	○	○	◕	(5)
Annual O&M (2)	○	◕	○	◔	◕	(5)
Revenue (2)	◔	◔	◔	◕	◕	(5)
Profit (2)	◔	◔	○	◔	●	(5)
Environmental						
Potential Issues	◔	◔	○	○	○	(6)
Socioeconomic						
ROW Impacts (2)	◕	◕	○	○	○	○
Access Equity	◕	◕	◔	◔	◕	○
Deliverability						
Ability to Finance	◔	◔	○	○	●	(5)
Ease of Implementation	◕	◕	◔	◔	◕	○

Key to Ratings:

- ○ Favorable, highly feasible, cost-effective or no substantial effects
- ◔ Moderately favorable, beneficial, cost-effective or minor effects
- ◕ Not favorable, problematic, costly or potentially substantial effects
- ● Likely fatal flaw

Notes:

(1) HOV Lane rated where applicable
(2) Based on quantitative assessment of HOT Lane
(3) Based on percentage of vehicles in mixed-flow lane versus HOT lane
(4) Based on travel time savings in HOT lane
(5) Only incremental costs (above and beyond HOV project) compared for HOT lane alternatives
(6) environmenal review to begin in 2003

toll in the peak direction during the peak periods, would have the highest increment operations and maintenance costs and lowest net income (of about $700,000).

Table 6
Comparison of Annual Revenues to Incremental Project Costs (2002$)

HOT Lane Alternative	Annual Toll Revenue	Incremental O&M Costs	Net Income
1A – Barrier	$3,028,000	$598,000	$2,430,000
2A – Buffer	$3,028,000	$1,333,000	$1,695,000
3B – Striped, 1 access	$2,903,000	$618,000	$2,285,000
3C – Striped, continuous	$2,156,000	$968,000	$1,188,000
4A – Reversible	$2,039,000	$1,338,000	$701,000

Source: Parsons Brinckerhoff, Wilbur Smith Associates – April 2002

As part of the detailed evaluation, three of the five alternatives were recommended to be dropped from further consideration. These included Alternative 1A – barrier, Alternative 2A – buffer and Alternative 4A – reversible. The primary issues associated with the alternatives that were dropped include:

- Due to the short distance of the study corridor, the multiple interchanges and the use of the study corridor for local travel, a HOT lane that limits access to vehicles traveling the entire length of the corridor would not maximize the utility of an additional lane on Highway 1. More vehicles would be required to travel in the mixed-flow lanes, which would result in greater congestion in the mixed-flow lanes than under an HOV or mixed-flow alternative analyzed in the Caltrans *PSR*. In addition, HOV use would be constrained. (Alternatives 1A, 2A and 4A).
- Operations and maintenance issues related to the plastic pylon separation system, due primarily to the potential for of pylons being hit and scattered onto the highway (Alternative 2A).
- Perceived safety issues related to non-barrier lane separation (Alternative 2A).
- Traffic projections indicate additional roadway capacity required in both directions (Alternative 4A).
- Enforcement issues associated with lack of median enforcement area (Alternatives 1A, 2A and 4A).

For Alternative 3B (one intermediate access) and Alternative 3C (continuous access) it was determined that while there were issues associated with the implementation and operation, they warranted additional review and comparison to the HOV lane option being pursued by Caltrans. Following additional review of Alternatives 3B and 3C by the project team, the IPRT, the SCCRTC and the peer review agencies, Alternative 3C (continuous access) was found to be less desirable than Alternative 3C (one intermediate access) for the following reasons:

- Enforcement issues associated with striped lane separation as vehicles may weave in and out of the lane to avoid paying the toll
- Untested application of HOT lane technology for continuous access).
- The toll revenues during the PM peak period in the southbound direction are based on a toll rate of $4.00 for use of any portion of the HOT lane. This high toll rate, which is required to ensure that traffic flow in the HOT lane remains acceptable, may not be practical in operation, and may substantially reduce the projected toll revenues and/or increase the number of vehicles using the lane and impacting the traffic flow in this lane.

Alternative 3B (one intermediate access) was identified as the best of the five alternatives, although there were issues raised related to safety, enforcement and operations. A comparison of Alternative 3B with the HOV lane proposed in the Caltrans Draft *PSR* indicated the following:

- Based on current projections of travel growth and increase in HOV use in the corridor by 2020, the usage of an HOV lane would be high and an HOV lane would be well-utilized. As indicated previously, the travel forecasts for 2020 conditions may change in the future, which may change the projected increase in HOV use in the corridor.
- Considering the high projected HOV utilization, the implementation of a HOT lane would limit the number of HOV and single-occupant vehicles that could use the lane due to the limited access locations.
- Due to the short distances between the interchanges within the five-mile project limits, the intermediate access location would be closer to the northern end of the HOT lane, which would limit the benefits of the intermediate access.
- The intermediate access point may result in the potential for diversion of vehicles to other Highway 1 on-ramps in order to be able to access the HOT lane, which may affect circulation on local streets.

As discussed previously in Section 4.1, the Caltrans PSR analysis indicated that the provision of an additional lane between Morrissey Boulevard and State Park Drive would result in a bottleneck in the southbound direction where the three lanes merge back down to the two existing lanes. Analysis of the extension of the third lane south of the Larkin Valley/San Andreas Road interchange indicated that congestion throughout the study corridor in the southbound direction would be substantially reduced or eliminated. As a result, the SCCRTC and Caltrans intend to include an extension of the widening of Highway 1 between State Park Drive and Larkin Valley/San Andreas Road interchanges in the environmental review phase. The elimination of this bottleneck would reduce the travel time savings of a HOT lane and would not make any HOT lane configuration feasible for the southbound direction.

4.5 SCCRTC AND PEER REVIEW

The results of the Phase 1 assessment were presented to the SCCRTC in May 2002. In addition the Phase 1 effort results were documented in a summary memorandum (see Appendix K) that was distributed for review by the SCCRTC and by a peer review panel of entities familiar with

HOT lane operations in Southern California. The results of the SCCRTC and peer review are summarized below.

Review of May 2, 2002 SCCRTC Comments

Results of the Phase 1 study were presented to the Commission on May 2, 2002 in an advertised public hearing. Following the presentation, there was discussion between the Commission members and public comments were received. The primary issues raised by the Commission were:

- Enforcement would be difficult, especially with Alternative 3C (continuous access). Since there would be no dedicated CHP enforcement area, enforcement would have to be done similar to existing HOV-lane enforcement on Bay Area freeways (i.e., visual inspection). As a result, there would be a substantial potential for toll evasion.
- Since there would be only striped separation between the HOT lane and the mixed-flow lanes, safety issues may result. These safety issues would be exacerbated with Alternative 3C (continuous access), as vehicles may weave in and out of the lane to avoid paying the toll.
- Alternative 3C (continuous access) would dilute the concept of the HOT lane, which is typically a dedicated corridor between two locations.
- Neither striped lane separation of HOT lane from general lanes, nor continuous access have been implemented in any of the existing HOT lane facilities.

At the May 2, 2002 SCCRTC public hearing there were a number of issues and concerns raised by the members of the public, including: resources should be spend on improving bicycle access throughout county, instead of widening the freeway; freeway should be widened now, so process needs to be sped up as much as possible; continuous access would be better for transit; the five-mile segment is too short a distance to be effective, and there are many on- and off-ramps; enforcement would be difficult.

Peer Review of Phase 1 Summary

The Preliminary Summary Report for Phase 1 was distributed by SCCRTC staff to three entities familiar with HOT lane operations in Southern California (San Diego Association of Governments, Riverside County Transportation Commission and the SR 91 operators), as well as to the local California Highway Patrol (CHP) and the CHP division that serves the southern California HOT lanes. Comments were received from the three entities and from the local CHP.

In general, the summary report was well-received. There were no questions or concerns related to the methodology for the Phase 1 effort. In addition, there were no strong statements for or against the concept of a HOT lane on Highway 1 in Santa Cruz. Mostly operational issues were raised, including those identified by the Commissioners:

- CHP indicated that enforcement would be difficult without a median enforcement area.
- The operator of SR 91 Express Lanes highlighted potential enforcement and safety issues of the striped alternatives and associated costs.

- The representative of the operator of I-15 (SANDAG) highlighted enforcement as an issue and was surprised at the high level of toll revenues (although it should be noted that the toll revenues are based on growth projections for year 2020 conditions). He also pointed out that Alternative 3C (continuous access) would have fewer SOV vehicles than Alternative 3B (intermediate access).
- The Riverside County Transportation Commission representative indicated that while there were sound reasons for recommending Alternatives 3B and 3C, she suggested revisiting Alternative 3C (continuous access) related to safety, enforcement, tolling feasibility and revenues. Also indicated that public opinion polling could be worthwhile to assess attitudes regarding carpool lanes and HOT lanes, and to obtain an indication of the level of interest in the HOT lane concept.

Chapter 5
STUDY FINDINGS AND OUTCOME

This chapter reviews the results of the Phase 1 effort, identifies the lessons learned, and identifies options for future consideration of HOT lanes on Highway 1.

5.1 STUDY FINDINGS

While HOT lanes may have benefits elsewhere, the results of the *Feasibility Study's* Phase 1 effort indicated that HOT lanes in the Highway 1 study corridor would be subject to a number of substantial design and operational constraints. This finding is primarily due to the situation studied here; a 6.3 mile study corridor, with a proposed five-mile HOT lane, with limited right-of-way, multiple interchanges on the adjacent main lanes, and anticipated high levels of HOV traffic. Other findings related to a HOT lane on the Highway 1 study corridor include:

- A HOT lane could physically be constructed on Highway 1 in the study corridor. Alternative 3B (striped, intermediate access) and Alternative 3C (striped, continuous access) could be constructed within the right-of-way proposed for the Highway 1 widening/HOV project, while Alternative 1A (barrier), Alternative 2A (buffer) and Alternative 4A (reversible) would require additional right-of-way.
- Annual incremental capital costs would range from $2,500,000 to $21,000,000. The incremental capital cost of constructing Alternative 3B (intermediate access) and 3C (continuous access) would be relatively low since they can be constructed in the right-of-way proposed for the Highway 1 widening/HOV project.
- Incremental operation and maintenance costs would range from $600,000 to $1,300,000, and would be in addition to the costs that would be incurred by a new HOV lane.
- Annual net income from the HOT lanes would range from $700,000 to $2,400,000. The annual net income could be used to contribute to the incremental capital costs associated with the HOT lane, to pay for the capital costs of an HOV lane (about $240 million), to fund operation/maintenance costs, or to fund other projects such as transit improvements in the corridor.
- Alternatives 3B and Alternative 3C would have a greater capacity utilization (carry more vehicles) than Alternatives 1A/2A (barrier/buffer separation, no intermediate access) since more HOV and SOV vehicles would be able to access the lane. Alternative 3C would carry the greatest number of people.
- Under all alternatives, except for Alternative 3C, fewer vehicles are projected to use the HOT lane than the HOV lane alternative analyzed in the Caltrans *PSR*. This is due primarily to the high HOV use projected for the corridor by 2020, and the limited options for accessing the HOT lane in this corridor. As a result, congestion on the other mixed-flow lanes would not decrease with a HOT lane alternative as compared with the HOV lane alternative.

- All HOT lane alternatives would have enforcement issues associated with lack of median enforcement area. Alternative 3C (continuous access) would likely have additional enforcement and safety issues associated with striped lane separation, as vehicles may weave in and out of the lane to avoid paying the toll.
- In the northbound direction, the Highway 1/17 interchange, and in particular the fishhook, would continue to be a problem in the future, although the planned improvements associated with the Highway 1/17 merge lanes project will offer short term relief. This bottleneck is anticipated to result in vehicles spilling back into the HOT lane, which reduces the attractiveness and benefits of a HOT lane in this corridor.
- In the southbound direction, the potential extension of the Highway 1 widening from State Park to Larkin Valley/San Andreas Road would eliminate the projected bottleneck at State Park Drive (when the three lanes would merge to two lanes under the HOT lane alternative), and would reduce the potential travel time benefits of a HOT lane in the study corridor.

5.2 SCCRTC ACTION

At the televised June 13, 2002 SCCRTC meeting, the results of the peer review were reviewed with the Commissioners and potential options for the *HOT Lane Feasibility Study* and *Draft PSR* were identified (see Appendix L). The potential options presented included:

1. Drop HOT lane options from the *PSR* and proceed to Phase 3.
2. Drop the HOT lane options from the *PSR*, but conduct limited public outreach effort included as either a reduced Phase 2 or expanded Phase 3 of the *Feasibility Study*.
3. Include Alternative 3B (intermediate access) in the *PSR* for further review and conduct limited or full Phase 2 of the *Feasibility Study*.

Following Commissioner discussion, and receipt of public comments on the item, the Regional Transportation Commission voted to not include a HOT lane alternative in the Caltrans *PSR* and to not continue with Phase 2 of the *Feasibility Study*. The *Feasibility Study* proceeded directly to Phase 3 (documentation and wrap up of the *Feasibility Study*).

It should be noted that earlier at this same meeting, the Commissioners heard a Caltrans presentation on the *PSR* and voted to pursue a Highway 1 Widening/HOV lane alternative in addition to the No Build alternative in the Project Approval/Environmental Document (PA/ED) phase of the project. The mixed-flow alternative was dropped from further consideration.

5.3 LESSONS LEARNED

The lessons learned from Phase 1 of the *Feasibility Study* include:

- It may be difficult to widen a highway for HOT lane use if, by comparison, the HOV lane is projected to be heavily used, and when the facility is currently used heavily for local travel.

- Design of HOT lane entrance / exits should avoid creating additional bottlenecks. In the southbound direction, the drop from three lanes to two lanes (regardless of whether a HOT lane or HOV lane) is projected to create a bottleneck.
- Construction of new HOT lane may be more difficult than conversion of existing underutilized HOV lanes. Growth projections for Highway 1 indicate an increase in the proportion of 2+ and 3+ person carpools, suggesting that the HOV lane would be well-utilized. Had there been an existing HOV lane on Highway 1 that was underutilized and significant congestion in the mixed-flow lanes, a conversion of the underutilized lane to a HOT lane would be more understandable and acceptable to the public.
- It may be difficult to gain support for untested toll collection concept. Since there is no existing example of a continuous access HOT lane, the issues related to toll collection, enforcement and safety are difficult to overcome.
- A HOT lane project should include transportation improvements that would compliment HOV and HOT lane usage. For example, park-n-ride facilities near the entrances to the HOT lanes, expanded transit service that would benefit from the travel time savings of the HOT lane, etc.
- Local support of the HOT lane concept is critical throughout study process. There is a need for a political "champion" of a pricing project. In the *Feasibility Study*, neither business community leaders nor elected or appointed officials demonstrated much enthusiasm or a sense of urgency about the HOT lane proposal.

5.4 FUTURE OPTIONS

At this time, an HOV lane is the preferred option for providing the additional capacity on Highway 1 to improve existing conditions and to accommodate future traffic growth in the corridor. Conditions may change that might lead to revisiting the HOT lane concept. These changed conditions could include:

- If usage of the HOV lane does not meet the projected levels (due to downturn in economy or change in commute patterns, for example), resulting in underutilized HOV lanes. It is possible that there would also be greater support for HOT lanes as a transportation improvement under these circumstances.
- At this time it is anticipated that the HOV lane eligibility would be 2+ vehicles. If the HOV eligibility were to change to 3+, which may result in underutilized lanes, the potential for a HOT lane for use by HOV 2+ and/or SOVs via a toll could be revisited.

It should be noted that Alternative 3B (intermediate access) and Alternative 3C (continuous access) could be constructed within the right-of-way required and proposed for the HOV lane widening. The HOV lane could be designed to consider the potential for future implementation of a striped separation HOT lane, should a HOT lane become practical or desirable at some point in the future.